

ENERGY STAR® HOME ENERGY YARDSTICK

ENERGY STAR, with support from Oak Ridge National Laboratory and ICF Consulting, has developed a new web-based tool for measuring home energy performance and estimating potential for improvement. The tool ranks homes nationally against other homes on a 0 to 10 scale based on total annual energy use after adjusting for size, age, number of occupants and climate. A home's final ranking depends on the efficiency and integrity of the building envelope as a system and the heating and cooling system. The ranking also depends on the efficiency of appliances, lighting and consumer electrics and occupant behavior.

Tool Application

The ENERGY STAR Home Energy Yardstick is only applicable for single-family attached and detached homes in the continental US that are occupied as a permanent place of residence. It does not adjust for significant energy use that is not typically residential, such as kilns, extensive welding, woodworking or metalworking. The tool was designed to be used by homeowners to evaluate the overall energy performance of their homes and draw awareness to the potential for improvement.

Inputs and Outputs

The Yardstick requires the following information:

- *Total Annual Energy Use* - The web-based tool will accept annual or monthly gas, oil and electric use. The applicable fuel and fuel units can be selected by the user on the input screen. Electricity is converted from site to source energy to account for the efficiency of electric power generation and transmission. All fuels are converted to British Thermal Units (Btu) and summed.
- *Conditioned Floor Area (sq. ft.)* - The conditioned floor area includes areas heated and cooled. An unfinished and unheated basement or attic should not be included.
- *Zip Code* - Used to determine heating degree days (HDD) and cooling degree days (CDD).
- *Number of Occupants* - Occupants must live in the house most of the year.
- *Age of structure* - The decade in which the house was built.
- *Electric Well Pump* - Does the home have an electric well pump? Well pumps consume considerable energy and are required to provide water for some residences. However, homes without wells (in cities or rural water districts) will not see the energy load associated with water and sewer service reflected in their electric bill. The web-based tool adjusts the total annual energy based on whether a home has an electric well pump so that homes can be compared on a fair basis.

Results are presented as a ranking (or score) on a 0 to 10 scale. The ranking is presented in two ways. First the ranking is illustrated on a simple graphical scale and displayed. Secondly, it is stated as the percentage of homes that perform better. Again, the purpose is to highlight the potential (or room) for improvement.

DEVELOPMENT OF THE HOME ENERGY YARDSTICK

Background of Data

The Home Energy Yardstick is based on public data obtained from the US Department of Energy's (DOE) Residential Energy Consumption Survey (RECS). RECS is a national, statistically based survey of building features, energy consumption, and energy expenditures in US homes. DOE's Energy Information Administration is responsible for administering RECS to collect statistical information about energy consumption and energy-related characteristics of residential buildings in the United States. EIA uses an in-person survey to collect information such as: the physical features of a building, occupancy characteristics and energy usage and cost. The most recent RECS was collected in 1997. For more information on the RECS data and other EIA publications, visit the EIA Web site at www.eia.doe.gov.

The 1997 RECS identifies 5 different housing types; single-family detached, single-family attached, apartment buildings with 2-4 units, apartment buildings with 5 or more units, and mobile homes. Records of 4213 single-family detached and attached homes are included in the database. This subset of homes was reduced by excluding homes with the highest and lowest energy use. Because the dataset is log-normal, 5.2% of homes were excluded based on the natural log (ln) of total energy use. In addition, 123 homes were excluded because of uncertainty about whether water heating energy use was included. A total of 3876 single-family home records were used as the basis of the tool.

Model Development

A process called step-wise linear regression analysis was performed on the 1997 RECS data to identify: 1) the drivers of building energy consumption (e.g., physical characteristics, building use, occupancy patterns, etc.); and 2) the relative impact of these drivers on energy consumption. The results of the analysis lead to the development of the following algorithm as the basis of the Yardstick. This algorithm was selected through a process of balancing policy goals, model simplicity (obtainable, objective, minimal and physical reasonableness of model parameters) and statistical indicators (R^2 , ANOVA).

$$\text{Adjustment} = \frac{C_0 + (C_1 \times \text{FloorArea}) + \begin{bmatrix} C_2, \text{ if 1 occupant} \\ C_3, \text{ if 2 occupants} \\ C_4, \text{ if 3 occupants} \end{bmatrix} + (C_5 \times \text{HDD65}) + (C_6 \times \text{CDD65}) + (C_7, \text{ if well pump}) + \begin{bmatrix} C_8, \text{ if built before 1939} \\ C_9, \text{ if built 1980-89} \\ C_{10}, \text{ if built after 1990} \end{bmatrix}}{\text{Model Mean}}$$

This algorithm is used in the Yardstick to normalize (adjust) a home's actual energy use. The adjusted energy is compared to other homes in the distribution of adjusted annual energy use from the subset of homes in the 1997 RECS used for this tool. The Yardstick score represents the performance of the home compared with other homes after adjusting for size, occupancy, climate, and age of the home.